(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 059 033**
A1

(12) **EUROPEAN PATENT APPLICATION**

(21) Application number: 82300547.5

(22) Date of filing: 03.02.82

(51) Int. Cl.³: B 07 C 5/346

(30) Priority: 24.02.81 ZA 811231

(43) Date of publication of application: 01.09.82
Bulletin 82/35

(84) Designated Contracting States: AT BE CH DE FR GB IT LI LU NL SE

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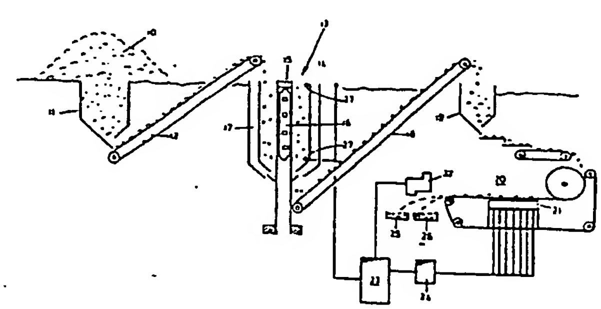
(54) **Ore sorting.**

(57) In an ore sorting apparatus, ore particles are bombarded with neutrons in a chamber 13 and sorted by detecting radiation emitted by isotopes of elements, such as gold, forming or contained in the particles, using detectors 21 and selectively controlling fluid jets 22. The isotopes can be selectively recognised by their radiation characteristics. In an alternative embodiment, shorter life isotopes are formed by neutron bombardment and detection of radiation takes place immediately adjacent the region of bombardment.



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ORE SORTING

BACKGROUND OF THE INVENTION

THE invention relates to ore sorting.

In a known type of ore sorting equipment, ore rocks are presented to scanning apparatus in a plurality of streams in which individual ore carrying particles are spaced apart. The scanning apparatus determines the characteristics of the individual particles which are then sorted according to those characteristics while moving in the parallel streams. Such equipment is described for example in South African Patent No 78/2327.

Present scanning and detection methods relying on levels of light reflectivity for example are not normally sufficiently accurate especially when detecting very small quantities of ore per unit volume of ore bearing particles so that economically viable particles are sometimes incorrectly sorted by being undetected and rejected in present methods. This is especially a problem as the need for sorting poorer quality ore bearing materials becomes more important due to the rise in the economic value of rare metals.

SUMMARY OF THE INVENTION

According to one aspect of the invention there is provided a method of sorting ore bearing particles including neutron bombarding the particles to form isotopes of elements contained in or forming the ore particles and detecting radiation of selective isotopes to identify the corresponding selective element bearing particles to be sorted from other particles, and sorting the identified particles from the other particles.

According to another aspect of the invention there is provided an apparatus for sorting ore bearing particles comprising a transport system for the ore particles including a station at which the particles are subjected to neutron bombardment

to convert one or more of elements contained in or forming the ore particles into isotopes of the elements, and a further station at which there is radiation detector means arranged to provide control signals in response to radiation emitted from selective isotopes to enable sorting of the corresponding selective element bearing particles from other particles.

BRIEF DESCRIPTION OF THE DRAWINGS

An ore sorting apparatus and method according to the invention will now be described by way of example with reference to the accompanying schematic drawings in which:

Figure 1 shows one fom of the apparatus; and

Figure 2 shows a different form of the apparatus.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring to the drawing, in Figure 1 a stockpile 10 of crushed gold bearing rock ore particles is provided above a hopper 11. A transport conveyor 12 feeds the particles from the base of the hopper 11 to the top of an irradiation chamber 13. The chamber 13 is provided with a central cylindrical tube 14 extending into the ground and an upper neutron shielding plug 15 at the top of the tube 14. A cylindrical slug 16 fits into the tube 14 and carries a plurality of neutron irradiating units. The chamber 13 has an outer jacket 17 providing a shield to confine neutron irradiation made of concrete, water and wax for example. The ore particles pass down the chamber 13 between the tube 14 and the jacket 17 to be discharged onto a transport conveyor 18.

The conveyor 18 delivers the ore particles to a hopper 19 from where the particles pass to a conveyor system 20 which may be generally as described in South African Patent No 78/2327.

In the conveyor system 20 the ore particles are formed into discrete streams of separated particles and pass an array of detectors 21. Fluid jet supply 22 includes one or more arrays of fluid jets (not shown) and is rendered selectively operative by an electronic processor 23. The processor 23 receives signals from a detector analyser 24 connected to the detectors 21 and initiates the fluid jets correspondingly to divert selected particles from their natural trajectory towards a reject bin 25 into a selected ore

bin 26. The processor 23 is provided in this embodiment and connected to level sensors 27 to ensure, by varying the conveyor transport speeds, that correct or suitable irradiation is taking place in the chamber 13.

The detectors 21 are arranged in an array along the path of the discrete streams as well as across streams. The detectors 21 are sensitive to gamma radiation and provide for each stream a pulse pattern which can be analysed by the analyser 24 to determine the presence and characteristic of ore particles passing the detectors.

The method and apparatus described operates and depends on the conversion of gold in the ore particles being converted at least partially from gold 197_{Au} to gold isotope 198_{Au}. The gold isotope exist for a period of time (half life around 2.7 days) during which the isotope emits gamma rays which are detected by the detectors 20 to identify selectively gold bearing particles from the remainder of the particles in the discrete streams. As such, the selection may be much more reliable and more sensitive than provided in earlier proposals which relied on light reflection and the like.

Normally, it is required that all particles passing through the chamber 13 are subjected to at least substantially the same amount of radiation. In practice therefore it is preferable that the particle sizes are selected into grades for passage through the chamber 13. Similarly it is preferred to transport ore particles through the chamber along spiral paths, tumbled progressively downwards in stages or otherwise positively fed through the chamber 13. Likewise, the radiation sources are distributed in the chamber in a suitable manner to ensure that ore particles passing through the chamber 13 are subjected to as even distribution of radiation as possible.

The radiation may be provided from any suitable source of neutrons including sources based on Californian 252, neutron emitters such as provided by the bombardment of Beryllium or other target elements by Radium, Americium 241 or other radio isotopes, particle accelerator neutron generators or a small nuclear reactor.

It will be appreciated that when sorting ore particles containing gold, the gold isotopes have relatively long half-lives, as explained above. For long half-life isotopes of gold or other elements, the embodiment of Figure 1 may be modified

or controlled to allow the ore particles to be stored for a period of say 24 hours. This can be achieved in separate dedicated storage bins (not shown) or in the hopper 19. By storing the ore particles, isotopes having relatively shorter half-lives will decay during storage to a level at which the radiation emitted will not interfere with later radiation detection from the desired isotope. This enables later selection of the desired elements, using gamma ray detection, provided by the detectors 21, to be more accurate. If the delay is too short, significant gamma radiation from shorter half-life isotopes may still be present when the ore particles pass the detectors 21 and cause erroneous selection of the desired ore bearing particles. In other words, where elements are present in the ore particles which not required to be sorted whose isotopes have half-lives which are short relative to isotopes of elements required to be sorted, it is an advantage to delay the detection of gamma radiation until such isotopes have at least significantly decayed so that only isotopes of the longer life elements then emit appreciable radiation during detection. This delay may be present by the inherent throughput speed or specially provided by storage. Further, where two or more different longer half-life isotopes are produced by neutron bombardment, a delay period or periods can be selectively chosen so that only the isotopes of interest emit the major amount of radiation in the required energy window for detection.

In Figure 2, the embodiment is provided particularly, and in contrast to the embodiment of Figure 1, for sorting ore particles by forming relatively short half-life isotopes. The embodiment of Figure 2 is arranged to expose the ore particles to neutron bombardment at a station adjacent gamma radiation detectors. In this way isotopes having a short half-life, of only say around 1 minute such as isotopes of manganese, can be detected to enable sorting of the ore particles.

The ore particle transport system can be generally as described in South African Patent No 78/2327, and comprises a conveyor belt 100 above which is mounted an array of neutron sources 102. Particles on the belt are exposed to neutron bombardment and isotopes formed are detected by an array of detectors 104. Arrays 106 and 108 of fluid jets are controlled by a detector analyser 110 to sort the particles by selective impingement of fluid from the fluid jets in an otherwise conventional manner.

In Figure 2, the embodiment is arranged to select two types of ore particles by sensing gamma radiation and detecting the characteristic radiation energy at different energy levels characteristic of selective isotopes to determine the presence of those isotopes. In this way for example Aluminium and Manganese bearing ores may be separately selected from the remainder of the ore particles, each providing in effect an identifiable signature recognised by detector signals supplied to the detector signal analyser 110.

The embodiment of Figure 2 may be arranged to detect only one type of isotope or more than two types of isotopes, as desired.

It will also be appreciated that the particular ore particle transport systems described are examples only of systems that may be used in carrying out the invention. The throughput speed and configuration as has been explained depends mainly on the half-life of the isotopes formed by neutron bombardment but can also depend on the amount of bombardment used. In this way the selection of one or more isotopes from other isotopes for detection can be enhanced. Where ore sorting is dependent on forming and detecting relatively long half-life isotopes a relatively slow throughput speed is used, or a specific delay or storage arrangement provided, to allow any short half-life isotopes to at least significantly decay before reaching the gamma radiation detectors. Where selection is based on forming short half-life isotopes, the detecting is arranged to follow a certain relatively short time, which can also be selective, after neutron bombardment. In the latter case, bombardment stations and detector stations are arranged close to one another to allow the isotopes to be detected shortly after they have been formed.

Conveniently, scintillator detectors are used for detecting the gamma radiation but other suitable radiation detectors may be used.

The methods and apparatuses described may be used for sorting a wide variety of elements or element bearing particles from other elements or waste material. The selection of particular elements from other elements can be carried out by differing the neutron bombardment and by sensing different types or energies of radiation, including α and β radiation, emitted by their isotopes.

Whereas the apparatus described in Figure 1 includes a neutron bombardment station which is underground, the bombardment may take place other than in an underground site.

CLAIMS :-

1.

A method of sorting ore bearing particles characterised by neutron bombarding the particles to form isotopes of elements contained in or forming the particles, detecting radiation produced by selected isotopes to identify corresponding selective element bearing particles, and sorting the identified particles from other particles.

2.

A method according to Claim 1, characterised in that the neutron bombarding takes place in an underground station.

3.

A method according to Claim 1, characterised by detecting different types or energies of radiation emitted by the isotopes to distinguish different isotopes from one another.

4.

A method according to Claim 1 for sorting particles which form relatively long life isotopes, characterised by delaying the passage of particles after bombardment, and detecting the radiation after the delay so as to allow any shorter half-life isotopes to at least significantly decay.

5.

A method according to Claim 1, for sorting ore particles which form short half-life isotopes characterised in that the bombarding takes place immediately before detecting radiation produced by the isotopes.

6.

Apparatus for sorting ore bearing particles characterised by a transport system for the ore particles including a station at which the particles are subjected to neutron bombardment to convert one or more of the elements contained in or forming the ore particles into isotopes of the elements, and a further station at which there is radiation detector means arranged to provide control signals in response to radiation emitted from selective isotopes to enable sorting of the corresponding selective element bearing particles from other particles.

7.

Apparatus according to Claim 6, characterised by means for delaying the progress of the ore particles after bombardment to allow shorter half-life isotopes to decay at least significantly before being supplied to said further station.

8.

Apparatus according to Claim 6, characterised in that said further station is arranged to provide control signals selectively indicative of the presence of two or more different isotopes at the further station.

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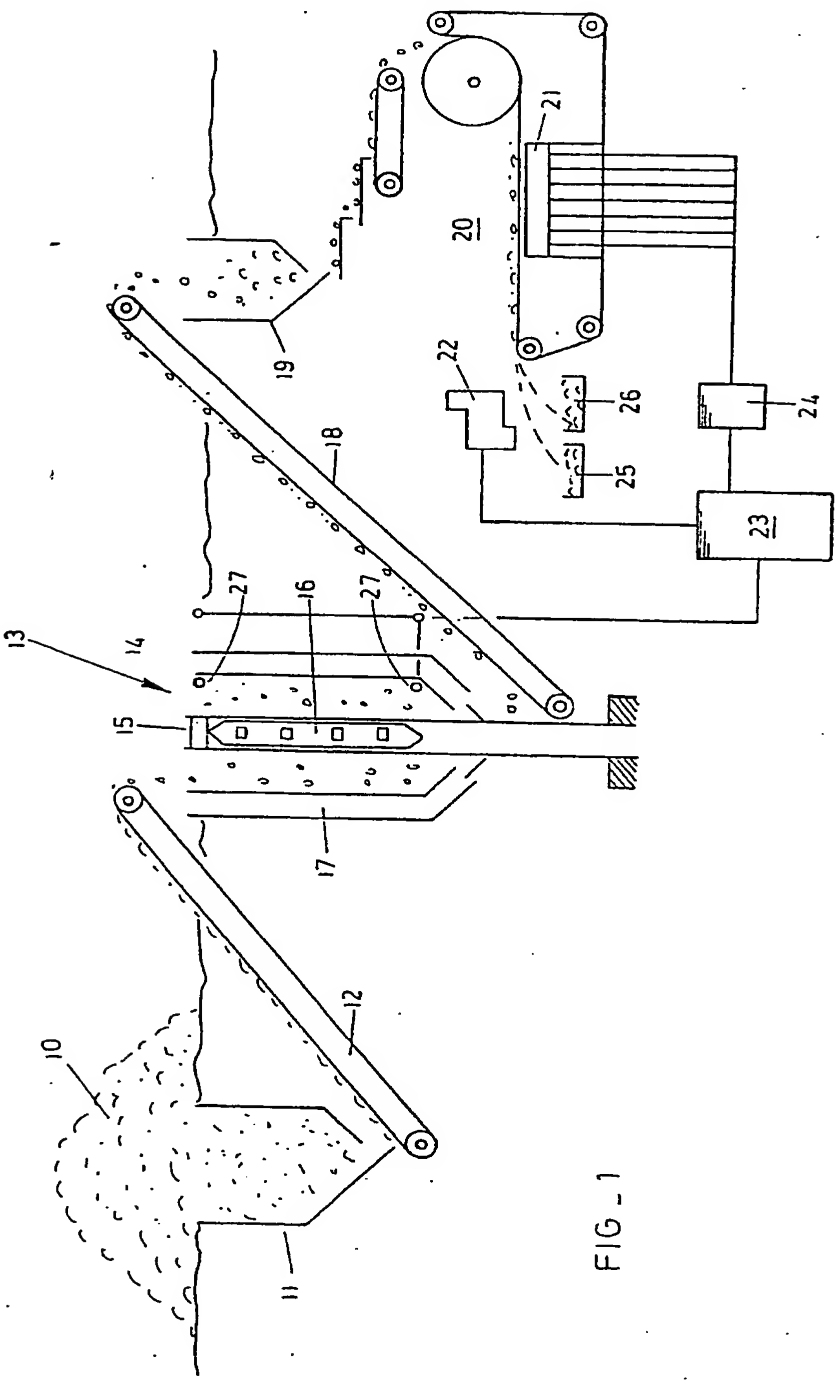
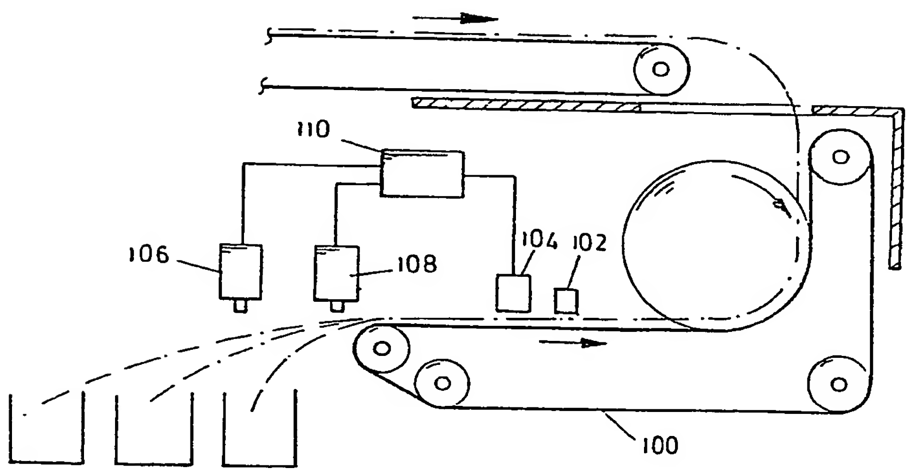


FIG_1

FIG_2



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EUROPEAN SEARCH REPORT

Application number

EP 82 30 0547

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
X	US-A-3 237 765 (GAUDIN) *Figures 1-3; column 1, line 11 to column 2, line 18; column 4, lines 10-50, column 5, lines 25-28*	1,3-7	B 07 C 5/346
A	GB-A-2 019 338 (SPHERE INVESTMENTS LTD) & ZAA 78/2327 (Cat. D)	1	
A	GB-A-1 103 591 (NATIONAL RESEARCH DEVELOPMENT)	1	
A	US-A-2 707 555 (GAUDIN)	1	

TECHNICAL FIELDS SEARCHED (Int. Cl. 3)

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	13-05-1982	PESCHEL W.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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